EQUIP: International Collaboration in Laboratory Services

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Abstract

Iodine, an essential element for thyroid function, is necessary for normal growth, development, and functioning of the brain and body. Iodine deficiency disorder (IDD) is a well documented global health problem that affects more than a billion people worldwide. Urinary iodine (UI) directly reflects the body's iodine status. Until 2003, no standard reference materials were available to measure urine iodine. In 2001, the Centers for Disease Control and Prevention (CDC) established a program,

EQUIP

Ensuring the Quality of Iodine Procedures

designed to improve the quality of urinary iodine measurements worldwide. Initially, CDC shipped urine samples to 34 laboratories from 24 countries. Most recently, in February 2005, we shipped the tenth EQUIP round, to 48 laboratories in 32 countries.

EQUIP Background:

Laboratories measuring urinary iodine worldwide were invited to join EQUIP. CDC's laboratory and two other laboratories used ICP-MS to measure UI.

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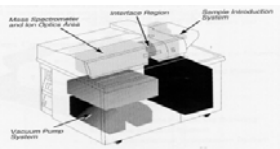


ICP-MS Major Subsystems

ICP-MS offers:
High sensitivity
Low detection limits
Wide linear range (from ppt to ppm)
Fast scanning
High sample throughput
Minimum sample preparation
Small sample requirements 100 µl
Low detection limits – 0.5µg/l
Normal population UI levels fall within linear range on the calibration curve

Most of the participating laboratories used spectrophotometric monitoring of the Sandell-Kolthoff reaction with sample digestion accomplished by using either ammonium persulfate digestion (APD) or chloric acid digestion. Below are components of the manual spectrophotometric method.

Standard Solution for the APD

Heating Block

The reduction of the yellow Ce(IV) to colorless Ce(III).

Spectronic 20D+

Table 1. Description of Methods used by Laboratories Participating in EQUIP

Method	Description of Method	No. of Laboratories
1	Ammonium persulfate digestion; spectrophotometric analysis manual	23
2	Chloric acid digestion; spectrophotometric analysis manual	13
3	All other methods: micro-plate reader, auto-analyzer, dry ashing, and ICP-MS,	12

Participating laboratories were asked during each of the nine EQUIP rounds to analyze, using their routine method, three to five samples containing different concentrations of iodine (range 10 to 300 µg/L) and to report the results to CDC on standardized EQUIP forms. Results were return to the laboratories from CDC so that each individual laboratory could compare its performance (mean and variance) with individual and composite data from all other participating EQUIP laboratories, whose identities were concealed. All laboratories have the option to seek and receive consultation from CDC laboratories.

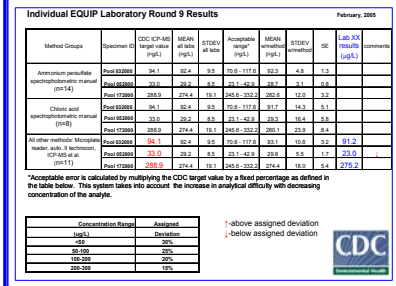
Table 2. Countries with laboratories participating in EQUIP.

1. **Australia – 3**
2. **Belgium – 1**
3. **Bulgaria – 1**
4. **Cameroon – 1**
5. **China -2**
6. **Ghana -1**
7. **Guatemala – 1**
8. **India – 1**
9. **Indonesia – 2**
10. **Ireland - 1**
11. **Italy – 2**
12. **Japan – 1**
13. **Kazakhstan – 1**
14. **Laos PDR – 1**
15. **Macedonia – 1**
16. **Madagascar – 1**
17. **Mongolia – 1**
18. **New Zealand – 2**
19. **PNG – 1**
20. **Peru – 2**
21. **Philippines – 1**
22. **Russia – 2**
23. **South Africa – 2**
24. **Switzerland – 1**
25. **Tanzania – 1**
26. **Thailand – 3**
27. **Ukraine – 1**
28. **USA – 4**
29. **Uzbekistan – 2**
30. **Venezuela – 2**
31. **Yugoslavia – 1**
32. **Zimbabwe - 1**

Table 3. Distribution and type of laboratories participating in EQUIP.

Continent	Type of Laboratory			
	Academic	Government	Research Institute	Medical
Africa	2	4		2
Asia	2	5	3	2
Australia-Oceania	3	3		1
Europe	4	4	2	2
North America	1	2		1
South America	2	2	1	

Figure 1. Example of EQUIP Laboratory Report



Individual EQUIP Laboratory Round 9 Results — February, 2005

Method Groups	Specimen ID	CDC ICP-MS target value (ng/L)	MEAN all labs (ng/L)	STDEV all labs	Acceptable range* (ng/L)	MEAN w/method (ng/L)	STDEV w/method	SE	Lab XX results (ug/L)	Comments
Ammonium persulfate spectrophotometric manual (n=14)	Pool 032004	94.1	92.4	9.5	70.6 - 117.6	92.3	4.8	1.3		
	Pool 052004	33.0	29.2	8.5	23.1 - 42.9	28.7	3.1	0.8		
	Pool 172004	288.9	274.4	19.1	245.6 - 332.2	282.6	12.0	3.2		
Chloric acid spectrophotometric manual (n=8)	Pool 032004	94.1	92.4	9.5	70.6 - 117.6	91.7	14.3	5.1		
	Pool 052004	33.0	29.2	8.5	23.1 - 42.9	29.3	16.4	5.8		
	Pool 172004	288.9	274.4	19.1	245.6 - 332.2	280.1	23.9	8.4		
All other methods: Microplate reader, auto. & technicon, ICP-MS et al. (n=11)	Pool 032004	94.1	92.4	9.5	70.6 - 117.6	93.1	10.6	3.2	91.2	
	Pool 052004	33.0	29.2	8.5	23.1 - 42.9	29.8	6.5	1.7	23.0	↓
	Pool 172004	288.9	274.4	19.1	245.6 - 332.2	274.4	18.0	5.4	275.2	

*Acceptable error is calculated by multiplying the CDC target value by a fixed percentage as defined in the table below. This system takes into account the increase in analytical difficulty with decreasing concentration of the analyte.

Concentration Range (ug/L)	Assigned Deviation
<50	30%
50-100	25%
100-200	20%
200-300	15%

↑-above assigned deviation
↓-below assigned deviation

Participating laboratories are encouraged to evaluate their performance in EQUIP over time and by concentration ranges. CDC provides the tools to do this evaluation by supplying supplemental data reviews that not only look at the current round of participation, but that expand to include all rounds of participation by a particular laboratory. By looking at trends in performance a laboratory can identify areas that may need to be further evaluated with regards to the accuracy of the analytical data that is reported for urine iodine measurement.

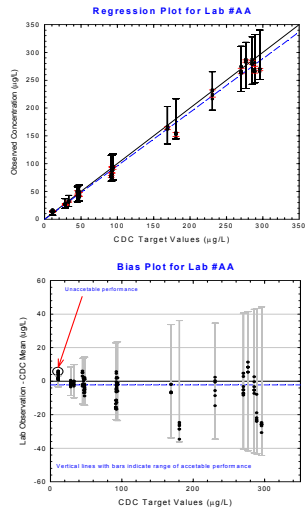


Figure 2: 3 year performance summary by concentration of urine iodine. This is an example of one laboratories performance over eight rounds of EQUIP. The laboratory had satisfactory performance in most of the challenges. The graphs indicate that the laboratory failed to meet acceptable performance criteria for some challenges below 20 ug/L urine iodine.

International Resource laboratories for Iodine (IRLI) Network :

In 2001 at a workshop in Bangkok, Thailand, an international group interested in eliminating IDD met and established the International Resource laboratories for Iodine (IRLI) Network. Twelve of the laboratories participating in EQUIP and representing the World Health Organization (WHO) regions, have been selected to be IRLI Network laboratories to serve as an external monitor for other laboratories that provide clinical and salt-production data for the ongoing efforts to prevent IDD. In November 2002, these 12 laboratories met in Cape Town, South Africa with sponsoring organizations to develop roles and responsibilities for participating IRLI Network Laboratories. EQUIP will assist the IRLI Network's development by continuing to provide external quality assurance, collaborating on developing standards of operations, and provide training and assistance as needed to provide an effective system to eliminate IDD.

Roles and Responsibilities of IRLI Network Laboratories

- Train personal and facilitate technology transfer to national laboratories
- Analyze samples where appropriate and possible
- Form regional iodine laboratory networks
- Develop technical standards and external quality assurance/proficiency testing programs within their region
- Collaborate with the salt industry and other sectors on quality assurance and other relevant issues
- Share information with regional networks and communicate with the coordinating body and other interested parties
- Seek necessary resources to sustain the operation of regional networks

When ICP-MS was combined with EQUIP, the CDC program designed to produce inter-laboratory comparisons, analytical results from participating laboratories improved over time. This system ha become a key feature in developing IRLI Network, a system of support and quality assurance in the effort to eliminate IDD in the world. EQUIP will continue to be a tool available to laboratories performing urinary iodine determinations, providing an assurance of quality data.

Conclusions:

ICP-MS provides a stable measurement standard by which other laboratories can assess the accuracy and precision when measuring UI. When ICP-MS was combined with EQUIP, the CDC program designed to produce inter-laboratory comparisons, analytical results from participating laboratories improved over time. This system has become a key feature in developing the IRLI Network, a system of support and quality assurance in the effort to eliminate IDD in the world. EQUIP will continue to be a tool available to laboratories performing urinary iodine determinations, providing an assurance of quality data.

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